BRITISH JOURNAL OF TUBERCULOSIS AND DISEASES OF THE CHEST

Vol. XLII. July, 1948 No. 3

GENERAL ARTICLES

OPEN INTRA-PLEURAL PNEUMONOLYSIS IN THE TREATMENT OF PULMONARY TUBERCULOSIS

By R. ABBEY SMITH

From Fazakerley Sanatorium, Liverpool

Open intra-pleural pneumonolysis is the operation of division of adhesions between the two layers of pleura, through an incision into the pleural cavity, the division being effected under direct vision by the diathermy needle or scissors. Thirteen patients have been treated by this procedure during the last four years at Fazakerley Sanatorium. The purpose of this paper is to present the early results without prejudice and with full knowledge of the limited conclusions to be drawn from such a small number of cases. It is proposed, therefore, to consider only the facts.

The operation was first introduced by Friedrich (1908) for closing tuberculous cavities in the lung. An important technical improvement was added by Eloesser and Brown in 1924, who suggested enucleating the parietal end of short adhesions extrapleurally instead of by intrapleural division. Alexander (1937) described a personal series of 29 cases, which still remains the largest series of published cases. Morriston Davies (1933) described the operative technique, but did not give a personal opinion on when the operation might be used. Kayne *et al.* (Kayne, Pagel and O'Shaughnessy, 1939) referred to Alexander's work, but avoided expressing a verdict. Ustvedt (1942) made no mention of the operation in those cases with adhesions indivisible by a closed method; he would appear to prefer a thoracoplasty if the indications are for abandoning the artificial pneumothorax. Search of the literature on the surgical treatment of pulmonary tuberculosis from 1942 to the present day has not brought to light any original paper dealing exclusively with the operation; clearly it has achieved only a very limited popularity since its introduction.

Before describing the results in this present series, I propose to outline briefly the reasons for which the operation was undertaken in this series, the indications for its use put forward in the literature, its theoretical advantages and disadvantages over other surgical collapse methods and operative technique.

The Nature of the Problem

Each patient in this series was submitted to preliminary thoracoscopy to determine the divisibility or otherwise, by closed pneumonolysis, of adhesions preventing the satisfactory collapse of the lung by artificial pneumothorax. For various reasons the adhesions were considered indivisible, and the necessity for some form of further collapse therapy gave a choice from one of four alternatives: substituting collapse by pneumoperitoneum and phrenic crush, continuing with the artificial pneumothorax in its original unsatisfactory state, open intrapleural pneumonolysis, or allowing the lung to re-expand and performing an extrapleural pneumothorax. Significant complementary problems were the presence of active contralateral disease in 9 patients, and youthfulness in the remaining four. Before discussing the indications for an open operation, it need hardly be emphasised that only a small percentage of all the patients with adhesions unsuitable for closed pneumonolysis who were treated during the four-year period of this report were subjected to the major operation of open pneumonolysis.

Indications for Open Intrapleural Pneumonolysis

The opinion of Alexander (1937) so fairly sums up the indications for the operation in this series that his judgment is quoted: " I believe that open intrapleural pneumonolysis should be reserved for those patients in whom phrenic paralysis, if indicated, and closed intrapleural pneumonolysis have already been tried, and in whom thoracoplasty is contra-indicated, and to whom therefore the open pneumonolysis operation offers the only chance of recovery." Roberts (1946), however, stated: " This operation is rarely if ever indicated," and cites massive post-operative effusion and empyema as sequelæ. This authoritative statement is of interest when considered with recently published figures of the mortality and post-operative infection rates of pulmonary resection—6 per cent. early mortality and no empyemata or fistulæ in 35 consecutive cases (Overholt, Wilson, Szypulski and Langer, 1947), and that of post-operative empyema following closed internal pneumonolysis—3·7 per cent. (Laird, 1945); which suggest that revision of the accepted view of open pneumonolysis may be desirable. The results of the operation detailed in this small series do not wholly support the above opinion expressed by Roberts. It is possible that the numbers considered suitable for this operation may increase as the intrinsic risk of thoracotomy diminishes, provided selection remains rigid, and that the adhesion section is not carried beyond a safe limit.

Advantages of the Operation

Advantages of the open over the closed operation claimed some years ago are no longer recognised as such by those familiar with the technique of closed internal pneumonolysis. In listing the advantages of the open operation over extrapleural pneumothorax one must assume the achievement of a satisfactory relaxation of the lung by the operation. As thoracoplasty deals with different clinical and pathological states of the disease, it will not be considered applicable to the cases under discussion. The creation of a functionally sound artificial pneumothorax by open pneumonolysis has the following

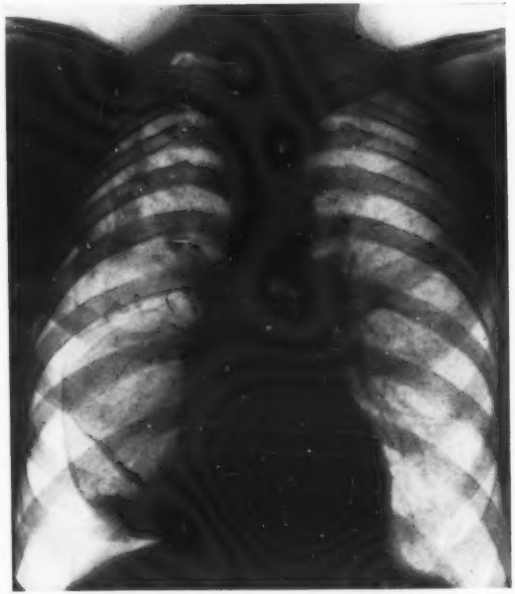

FIG. 1.—CASE 2: 31.10.44. AFTER INDUCTION OF RIGHT A.P.
Indivisible Adhesions.

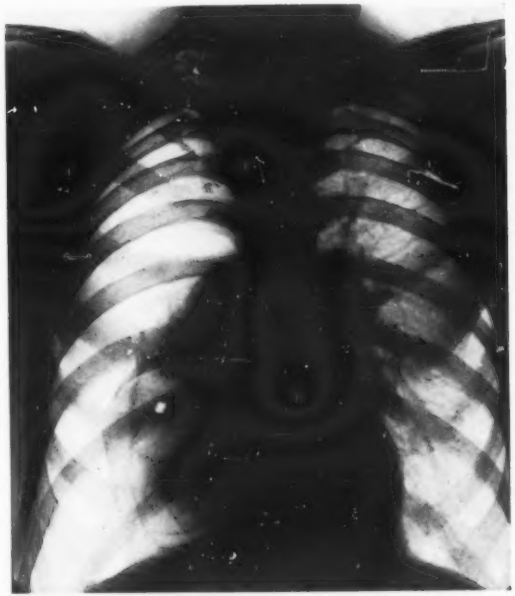

FIG. 2.—CASE 2: APPEARANCE AT LAST EXAMINATION, 1.7.47, AFTER OPEN PNEUMONOLYSIS ON 9.11.44.
Good collapse and cavity not visible.

To face p. 52

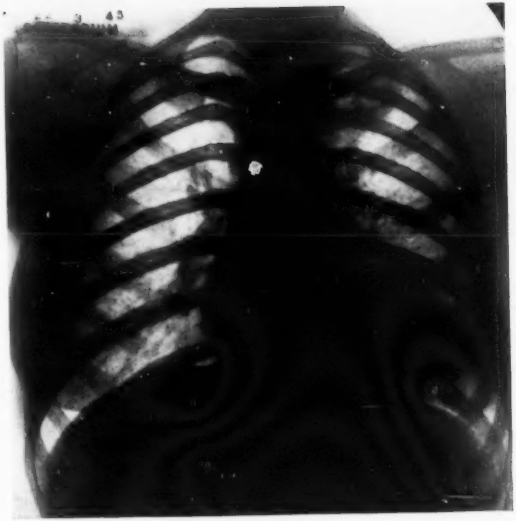

FIG. 3.—CASE 7: 22.3.45. BEFORE INDUCTION OF LEFT A.P.
Multiple cavities in left upper lobe with bilateral disease.

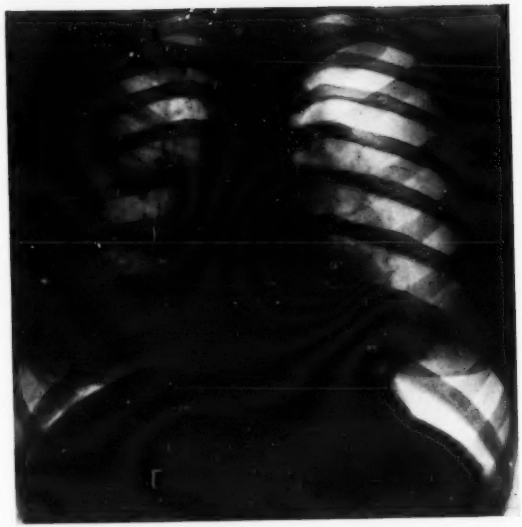

FIG. 4.—CASE 7: 17.8.45. AFTER INDUCTION OF LEFT A.P.
Indivisible apical adhesions and patent cavities.

PLATE IX.

obvious advantages: It does not produce a permanent collapse; the bony thorax is left intact; the operation can be rapidly completed in one stage; it produces a less mutilating and mechanically more perfect collapse than with other methods, and the control of the affected side thus obtained reduces the gravity of a spread to or extension of disease on the contralateral side.

Disadvantages of the Operation

The most pertinent disadvantage is that an artificial pneumothorax space is essential to allow of thoracoscopy on the side on which the operation is contemplated. Further, the extent of adhesion division may fall short of that hoped for from the preliminary thoracoscopy, and important apico-mediastinal adhesions apparently amenable to section by open operation may patently not be so when examined, the end result of the operation being worse than the primary condition. In addition, the patient is exposed to the combined complications of thoracoscopy, thoracotomy and artificial pneumothorax, which, if providing adequate collapse in the early post-operative days, may not continue so to do. Including possible complications as disadvantages, one should mention the following as being associated with the operation: Loss of the pneumothorax space and surgical emphysema of the chest wall from air leakage at the suture line, persistent hæmothorax, the development of a tuberculous or pyogenic empyema, pleuro-cutaneous fistula, and breakdown of the thoracotomy suture line—a fatal complication in 2 of O'Brien's 3 cases of "burst thorax" (O'Brien, 1932). Infection and the early mortality rate, the two prime causes for the relative disfavour of the operation, will be discussed in more detail.

Operative Technique

Under cyclopropane anæsthesia the approach in all but one case has been through the second rib interspace anteriorly. A perichondral flap is turned downwards from the second rib, and one elevated upwards from the third rib (Morrison, 1947). When sutured together at the end of the operation, wound closure is facilitated. The anterior ends of the second and third ribs are divided, and a 3-inch incision made into the pleural cavity. The adhesions are divided, between artery forceps where possible, with the diathermy coagulating needle. For the thick, short sheets, the manœuvre of Eloesser is employed (those on the mediastinal surface are the problems). Hæmostasis is confirmed and the pleural cavity dried. To control the freed apex of the lung, and prevent it re-adhering to the parietal pleura during the immediate post-operative period when the patient cannot be nursed in the optimum position, J. T. Morrison uses the following technique. A suture is passed through a healthy part of the visceral apical pleura and left untied. It is then brought out through the wound under just sufficient tension to hold the apex away from the chest wall and the position marked by measuring the distance between the free end of the suture and the skin surface. The wound is then closed in layers, an airtight suture line being imperative. The suture holding the apex is then tied in the position previously estimated. Pressure is made on the wound by a roll of gauze and the intrapleural pressures adjusted. Post-operatively, the position in which the patient is nursed, the

control of the artificial pneumothorax and the early aspiration of the almost inevitable hæmothorax are important. The holding suture is removed when the patient is able to sit up in bed and co-operate in maintaining this position—that is, within the first twenty-four hours. The success of the operation would appear to depend, to a large measure, on meticulous attention to details of treatment during the first fortnight or so after operation. O'Brien (1932) ascribed one of his cases of wound disruption to the use of an excessive intrapleural pressure in an attempt to prevent lung expansion. The pressure used was +18 cms. but the post-operative day on which the accident occurred is not stated.

Case Reports and Discussion

Details of the 13 cases are shown in Table I. Speaking generally, they are a relatively young group of patients with short histories of disease and with an active bilateral infection in all but 4 cases. An assessment of their general condition is noted. The site of the cavity for the closure of which the operation was undertaken is given, and an empirical division of the cases

		Sex.	*Age.*	*Length of History.*	*General Condition.*	*Extent of Disease.*	*Site of Cavity.*	*Temperature.*	*Sputum.*	*E.*
1.	G. D.	F.	19	Recent	Good	Bilateral	R.U.L.	Afebrile	Positive	
2.	P. M.	M.	21	Recent	Fair	Unilateral	?R.U.L.	Febrile	Negative	
3.	R. W.	M.	19	1 year	Good	Unilateral	R.U.L.	Afebrile	Negative	
4.	E. M.	F.	29	15 months	Fair	Bilateral	L.U.L.	Afebrile	Positive	
5.	E. H.	F.	24	3½ years	Fair	Bilateral	R.U.L.	Afebrile	Positive	
6.	D. P.	F.	26	1½ years	Fair	Bilateral	L.U.L.	Afebrile	Positive	
7.	M. Mc.	F.	15	Recent	Fair	Unilateral	L.U.L.	Febrile	Positive	
8.	M. Gl.	F.	28	3 years	Poor	Bilateral	R.U.L.	Febrile	Positive	
9.	A. M.	F.	17	15 months	Good	Unilateral	L.U.L.	Afebrile	Positive	
10.	B. B.	F.	25	26 months	Good	Bilateral	R.U.L.	Afebrile	Positive	
11.	M. G.	F.	29	Recent	Poor	Bilateral	L.U.L.	Afebrile	Positive	
12.	G. M.	F.	20	Recent	Fair	Bilateral	L.U.L.	Afebrile	Positive	
13.	M. L.	F.	17	1 year	Good	Bilateral	R.U.L.	Febrile	Positive	

made into the afebrile, and those exhibiting regular, small but significant rises in temperature before operation—the "febrile" group. No case had a phrenic crush before or after the operation. The inaccessibility of the adhesions, their short structure, multiplicity, or their abnormal vascularity or a combination of two or more of these, are the reasons for their indivisibility by closed pneumonolysis. The early results of the operation are given in the final column of the table. Seven are in good general health, with negative sputa, cavities closed and the affected lung controlled by a satisfactory artificial pneumothorax. Typical radiographs are shown in Figs. 1 and 2 (Plate VIII, Case 2) and Figs. 3 and 4 (Plate IX, Case 7) and Fig. 5 (Plate X, Case 7) to illustrate the appearances before and after operation. In Case 3 the artificial pneumothorax has been abandoned because of quiescent disease. Two cases are making satisfactory progress, Cases 6 and 13. In Case 6 the disease is quiescent on the operated side, and the cavity closed, but an artificial pneumothorax has been continued on the contralateral side for an extension of the disease. One (Case 10) is in the same state as before operation. Another (Case 1) is worse, with a patent

...cious ...ration.	*Reason for Indivisibility of Adhesions.*	*Date of Thoracotomy.*	*Complications.*	*Date of Discharge.*	*Weight since Operation.*	*Present Condition.*
...acos-...y+in-...plete ...ion	Length and inaccessibility	22.2.45	T.B. pyothorax	In-patient	Gain 7 lbs.	Cavity persists. Extension of contralateral disease. General condition poor.
...acos-...y+in-...plete ...ion	Multiplicity	9.11.44.	Obstructive jaundice	30.4.45	Gain 11 lbs.	Cavity not visible. No sputum. Disease quiescent. Feels well, doing light work.
...acos-...	Length and inaccessibility	22.3.45	Nil	15.10.46	Gain 15 lbs.	Cavity closed. No sputum. Disease quiescent. Feels well. Working as lorry driver.
...acos-...	Length	10.5.45	Nil	1.2.46	Gain 11 lbs.	Cavity closed. No sputum. Disease quiescent. Doing house work. Bilateral A.P.
...acos-...	Length and multiplicity	7.6.45	Tuberculous pyothorax	*Death* on	8.8.46	(14 months after operation). Cause: Tuber. enteritis.
...acos-...	Length and inaccessibility	23.8.45	Nil	In-patient	Lost 1 lb.	Disease quiescent on operated side (left). Active on right. Bilateral A.P. Outlook favourable.
...acos-...	Vascularity and inaccessibility	3.9.45	Nil	15.2.46	Gain 10 lbs.	Cavity closed. Sputum guinea-pig negative. Disease quiescent. Attending for A.P. refills.
...acos-...	Length and multiplicity	15.11.45	Septic wound. Staph. empyema. Pleuro-cutaneous fistula		*Death* on	23.1.46 (69th post-op. day).
...acos-...	Multiplicity and inaccessibility	17.1.46	Nil	29.11.46	Gain 12 lbs.	Attending O.P. Disease quiescent. Sputum negative. Cavity closed.
...acos-...	Not stated	24.1.46	Nil	In-patient	Gain 4 lbs.	As before operation. R.A.P. unsatisfactory. Sputum positive. Cavity patent.
...acos-...	Multiplicity	25.7.46	Nil	11.7.47	Gain 6 lbs.	Cavity closed. Sputum guinea-pig negative. Working, on bilateral A.P. Quiescent.
...acos-...	Length and inaccessibility	10.4.47	Nil	4.10.47	Gain 6 lbs.	Cavity closed. No sputum. Disease quiescent. Attending for A.P. refills.
...acos-...	Length and multiplicity	3.7.47	Nil	In-patient	Gain 2 lbs.	Cavity closed. Making progress. Outlook favourable.

cavity on the operated side, and is unfitted for thoracoplasty by extension of pre-existing disease in the opposite lung. The remaining 2 patients have died from extension of the disease, one on the 69th post-operative day and the other fourteen months after operation. It is of interest that these two (Cases 5 and 8), and the other poor operative result (Case 1) all developed an empyema. This complication materially alters the prognosis, and may indicate a low resistance to the disease rather than a frank operative failure. Additional information on those who developed empyemata is given in Table II. It will be noted that 2 patients had outstandingly longer histories of disease than the remaining 11, and that the interval between artificial pneumothorax induction and operation in these 2 was well above the average for the series. The use of the operation as a last resort to close a patent cavity has failed in these 2 instances. They indicate the type of case where a bad result may be anticipated.

TABLE II.—DETAILS OF CASES DEVELOPING POST-OPERATIVE EMPYEMA.

		Length of History.	*Interval between A.P. Induction and Thoracotomy.*	*Transient Effusion after A.P. or Thoracoscopy.*	*Pyrexia before Operation.*	*Cytology of Empyema.*	*Result of Operation.*
1.	G. D.	Recent	10 weeks	Present	Afebrile	Lympho-cytes + T.B.	Deterioration in condition.
5.	E. H.	3½ years	36 weeks	Present	Afebrile	Lympho-cytes + T.B.	Death (T.B. enteritis).
8.	M. Gl.	3 years	32 weeks	Not present	Febrile	Staph. No T.B. seen	Death (pleuro-cutaneous fistula).

Average interval between A.P. induction and Thoracotomy (whole series)=20 weeks.

Comparison with other Figures and Methods of Treatment

An absolute comparison with the results of Alexander's (1937) series cannot be made because of differences in classification. He gave an " excellent to good " result in 17 of the 29 cases (58·6 per cent.), and mentioned 3 deaths within the first five months (10·4 per cent.). He employed the classification of the National Tuberculosis Association (of America) for his extensive study of the effects of the operation in those cases he treated. Before comparing the results with other available methods of treatment when the stage is reached of failing to divide adhesions by closed pneumonolysis, a recapitulation of these methods might be permitted. They are to continue with the artificial pneumothorax in spite of adhesions preventing relaxation of the lung, extra-pleural pneumothorax after re-expansion of the lung, to abandon the artificial pneumothorax with no further surgery, or thoracotomy with division of the adhesions under direct vision.

Reid (1946) quotes Barrett's indications for the extrapleural pneumothorax operation; (1) bilateral disease with active cavitation, (2) young subjects, (3) patients with small apical lesions in which a selective artificial pneumo-thorax could not be obtained, (4) patients with an unstable lesion in the upper lobe. The operation of open pneumonolysis has been used in this series for a similar group of patients and a comparison with Reid's (1946) results of

PLATE X.

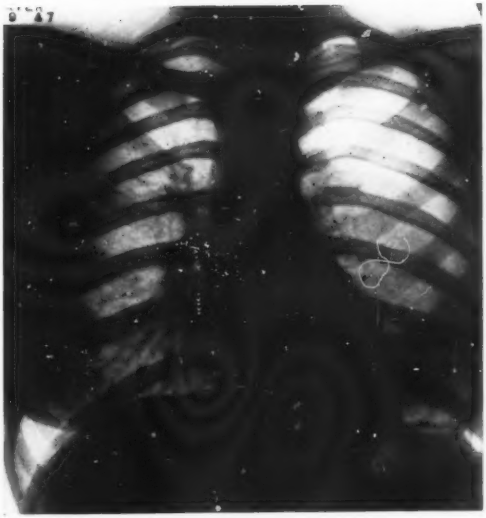

FIG. 5.—CASE 7: 9.9.47. APPEARANCE AT LAST EXAMINATION.
Good collapse and cavities not visible. Right side quiescent.

To face p. 56

extrapleural pneumothorax is made in Table III. As the induction of an artificial pneumothorax is an essential preliminary of an open pneumolysis operation, this very considerably reduces the numbers for which the operation is available. It must be remembered that in making this comparison the results refer to operations with widely different fields of applicability.

Another series of cases included in Table III is Branday's (1946). He followed up 100 cases with tuberculous cavities in the lung and adhesions indivisible by closed pneumonolysis, treated in every case by abandoning the artificial pneumothorax without additional surgery. In the three-year period of the follow-up he found only 34 were well and 39 had died; a striking argument in favour of some form of collapse therapy. Again, one should be cautious in drawing a conclusion of the merits of open pneumonolysis from a comparison with these figures, as no information is given on the all-important matter of the percentage of the responsible adhesions which could be safely sectioned or enucleated by this operation, when closed pneumonolysis had failed. They do give clear evidence, however, of the dismal results of abandoning an artificial pneumothorax in a series of cases in which indications for its use existed at the start of treatment.

TABLE III.

Method of Treatment.	*Number of Cases.*	*Discharged from Sanatorium in Good Condition.*	*Infection of E.P. Space or Empyema.*	*Early Mortality.*
Extrapleural Pneumothorax (Hugh Reid, 1946)	54	30 (55·5%)	15 (27·7%)	5 (9·3%)
Abandoning A.P. (W. J. Branday, 1946)	100	34 (34%)	—	39 (39%) within 3 years.
Open intrapleural pneumonolysis	13	7 (53·9%)	3 (23·1%)	1 (7·2%)

Summary

If this brief report has made out a case for re-assessment of the operation of open pneumonolysis in the treatment of pulmonary tuberculosis, in a surgical field in which certain bogeys of a decade ago have been laid, it will have achieved a purpose. So long as relaxation of the diseased lung remains a vital matter for the patient, I would submit that the possibilities of the operation should not too readily be put out of mind for the young patient with a short history of disease and a recently induced artificial pneumothorax, if the findings at thoracoscopy suggest the feasibility of a safe enucleation or section of adhesions by open operation, when closed pneumonolysis has failed.

The results in the 13 patients described in this paper were satisfactory in all but 3, despite the general feeling against the operation.

My thanks are due to Dr. O. F. Thomas, Medical Superintendent, for permission to make use of the case notes; and to him and Dr. V. Cotton Cornwall for advice and criticism.

Twelve of the cases were operated on by Mr. J. T. Morrison, and one by Mr. Ronald Edwards. I am grateful to them for permission to publish their results and for their help.

REFERENCES

ALEXANDER, J. (1937): "The Collapse Therapy of Pulmonary Tuberculosis," Thomas, Springfield, Ill.

BRANDAY, W. J. (1946): *Amer. Rev. Tuberc.*, **54**, 152.
DAVIES, H. MORRISTON (1933): " Pulmonary Tuberculosis: Medical and Surgical Treatment," Cassell, London.
FRIEDRICH, P. L. (1908): *Surg., Gynec. Obstet.*, **7**, 632.
KAYNE, G. G., PAGEL, W., and O'SHAUGHNESSY, L. (1939): " Pulmonary Tuberculosis," Oxford University Press, London.
LAIRD, R. (1945): *Tubercle*, **26**, 152.
MORRISON, J. T. (1947). Personal communication.
OVERHOLT, W. J., WILSON, J., SZYPULSKI, J. T., and LANGER, L. (1947): *Amer. Rev. Tuberc.*, **55**, 214.
O'BRIEN, E. J. (1932): *J. thorac. Surg.*, **1**, 603.
REID, HUGH (1946): *Thorax*, **1**, 215.
ROBERTS, J. E. H. (1946): " Modern Operative Surgery," 3rd ed., Cassell, London.
THOMAS, C. PRICE (1947): *Brit. J. Tuberc.*, **37**, 6.
USTVEDT, H. J. (1942): " Pulmonary Tuberculosis and its Treatment," Eng. ed., Bole, London.

PNEUMOPERITONEUM: ITS PLACE IN TREATMENT*

BY R. Y. KEERS

From the Red Cross Sanatoria of Scotland (Tor-na-Dee)

THE introduction of any new procedure for the treatment of pulmonary tuberculosis is indeed a notable landmark on the road along which the sufferer from this disease must travel. It is a road which is strewn with wrecked hopes and grievous disappointments of the past, and one can well understand both the enthusiasm and the scepticism with which a new procedure is greeted. Pneumoperitoneum, pioneered in the United States by Banyai as far back as 1934 but still regarded as a relatively new method of treatment, is garnering its full harvest of this enthusiasm and scepticism. Much work has been done on the subject in the intervening years, but reports and opinions have varied and it is still difficult to assign pneumoperitoneum to its exact place in treatment. The invitation to deliver this talk today set me delving again into the literature, and I turned up first of all the Survey into collapse therapy in the U.S.A. which was published by Drolet (1943). He found that in only forty-four of the ninety-nine hospitals surveyed had pneumoperitoneum been used at all, and then only on less than 1 per cent. of all the patients in these particular institutions. Furthermore, he invited comments on pneumoperitoneum from two surgeons and one physician, whose names are household words throughout the tuberculosis world, and received the following replies:

> " Pneumoperitoneum is a procedure too indirect to find much of a place in the treatment of pulmonary tuberculosis " (Overholt).
>
> " Pneumoperitoneums are occasionally used, but the popularity they had a few years ago in California has subsided " (O'Brien).
>
> " Pneumoperitoneum definitely has a place, but not the place which was claimed for it three or four years ago " (Matson).

* Delivered at a meeting of the Midland Tuberculosis Society at Birmingham on March 6, 1948.

We find also such an authority as the late Max Pinner (1945) dismissing pneumoperitoneum in the following terms: " For completeness' sake, mention is made of the suggestion to increase the rise of the paralysed diaphragm by inducing pneumoperitoneum. The results are not convincing: neither are those of pneumoperitoneum as an independent procedure." The other side of the picture is presented by Banyai, who, as one of the pioneers of pneumoperitoneum, is naturally enthusiastic and who has never wavered in his allegiance since 1934, although even his very comprehensive publication in 1946 still lacked specific figures in results and follow-up studies. Results have, of course, been reported—notably those of Rilance and Warring (1941 and 1944), Fowler (1941), Clifford-Jones and MacDonald (1943), Crow and Whelchel (1945), Anderson and Winn (1945), and Edwards and Logan (1945), all of whom obtained an appreciable percentage of successes and were convinced that pneumoperitoneum had a definite place in the treatment of pulmonary tuberculosis. More recently, Gilmore (1947) reported a small series of twelve cases, in seven of which an excellent result was obtained; while Mitchell and his colleagues (1947) reported, in a series of 710 cases, a 57 per cent. satisfactory result among white patients and a 32 per cent. success amongst coloured patients, the majority of their subjects having advanced disease. Murphy (1947), writing on the subject of thoracoscopy, remarks that " pneumoperitoneum has gained such an ascendancy over pneumothorax at the Oteen Veterans Administration Hospital in the past eighteen months that we are being called upon less frequently to perform a pneumonolysis," adding in a later paragraph that " the favourable results obtained here with pneumoperitoneum and our success with thoracoplasty, however, have tipped the scales towards conservatism in many questionable adhesions." This encouraging picture, however, is again offset by Hurst, Maier and Dwork (1947), who reviewed 103 cases and were obviously unimpressed by the procedure.

The impression, therefore, which one gets from the literature is somewhat confusing, and one is constrained to cast around in search of an explanation of the discrepancy in results which is so apparent. A partial explanation can, I think, be found in the type of case which has been subjected to the treatment. Pneumoperitoneum, like every other new method, has during its early phases been used largely on advanced bilateral cases for whom no other form of treatment has been possible. This is admitted by several of the writers quoted and is also implied in the remarks of others, who stress its value in raising morale. While no one would wish to deprive the patient with advanced tuberculosis of any small grain of comfort afforded by a pneumoperitoneum, I do not consider that this is material from which one can draw authoritative conclusions; nor do I feel that such possible psychological benefit should rank high amongst the indications. I believe that pneumoperitoneum is more than a placebo and that, if it is used with discrimination in a different type of case and with due respect to its limitations as a collapse measure, we shall be glad to include it in our armamentarium, along with that hallowed trinity—phrenic paralysis, pneumothorax and thoracoplasty. I have deliberately inserted the phrase, " with due regard to its limitations," for I think one must emphasise again and again that pneumoperitoneum should never be regarded as competing on equal terms with an effective and uncomplicated pneumothorax.

This remains the best of all forms of collapse, and even the most sensational diaphragmatic elevation does not constitute an adequate substitute.

Results

This communication is based upon patients treated at Tor-na-Dee Sanatorium during the past five years, who at the end of 1947 numbered seventy-four. These have been carefully reviewed in all their aspects, in the hope that a critical analysis will help to shed a little light on some of the problems which have vexed and confused us.

In all these seventy-four cases pneumoperitoneum was combined with phrenic paralysis, and the procedure was used in most instances with a definite objective in view. The only exceptions were four with far-advanced disease, from which we gained nothing except confidence in our technique. The results have been summarised briefly in the following table and classified under the headings Successful, Partially Successful, and Failed. In this assessment only the immediate objective for which the pneumoperitoneum was initiated has been considered. Thus, in patients with bilateral disease, in which the pneumoperitoneum had been designed to control the contralateral lung in preparation for thoracoplasty, a successful result has been recorded when stabilisation was sufficient to allow major surgery. It should be noted at this point that, in some cases where the original objective was a comparatively limited one, the ultimate result far exceeded expectations—a fact which makes it more than ever necessary to temper enthusiasm with discretion when drawing conclusions regarding the method as a whole. These comments will perhaps explain why the usual procedure has not been adopted and success or failure recorded in terms of sputa rendered negative or cavities closed. To do so would give a distorted picture of pneumoperitoneum and of its place in treatment. In many of these cases the pneumoperitoneum did not, and was never intended to, render the patient sputum-negative; but it nevertheless did all that was asked of it—and often more—in preparing the way for alternative forms of collapse which would otherwise have proved impossible.

	Supplementing partially effective artificial pneumothorax	*A.P. contraindicated or impossible*			*Far advanced disease*	*Total*
		Pneumoperitoneum and phrenic paralysis as sole measure	*Pneumoperitoneum and phrenic paralysis in preparation for major surgery*			
			Homolateral lung	*Contralateral lung*		
Successful ..	3	14	16	5	0	38
Partially successful	1	4	1	2	0	8
Failed	4	17	2	1	4	28
Total ..	8	35	19	8	4	74

A classification of the indications in this series has been incorporated in the table of results, for it is only by considering carefully the indications in

each series that a proper evaluation of the potentialities of the treatment can be reached. Thus the first column refers to eight patients in whom pneumoperitoneum was used to supplement a partially effective artificial pneumothorax. It must be made quite clear that in each of these there were contraindications to the substitution of a thoracoplasty for the artificial pneumothorax. The three successful results recorded in this group were in two subjects with basal cavitation and one with a mid-zone cavity held open by a short, indivisible adhesion to the posterior chest wall. Cavity closure with sputum conversion was obtained in each instance. The one partial success was in a basal case, where symptoms were abolished and a cavity reduced to the dimensions of a threepenny-piece, but without securing final obliteration. The other four were unaffected, and although one of these did come eventually to a successful thoracoplasty it was not felt that the pneumoperitoneum had contributed to this result.

The majority of the patients, however, have been those in whom an artificial pneumothorax was either contraindicated or impossible, and these have been divided into two sub-groups. In the first sub-group, pneumoperitoneum was utilised as the main line of attack and was not necessarily regarded as the prelude to major surgery. With fourteen successes out of a total of thirty-five cases the results in this sub-group are not particularly impressive, but they are very useful in indicating some of the limitations of pneumoperitoneum. Subjecting these fourteen successful results to closer scrutiny, we find that three were in patients with recent exudative disease without cavitation; four with infiltration, not necessarily of recent origin, but again without cavitation; while six others were obtained in subjects with definite cavities, but cavities which were not surrounded by any significant degree of fibrosis or infiltration. In the fourteenth case there was a mid-zone cavity with an appreciable amount of infiltration and fibrosis. Two of the cavities which responded were dorsal lobe cavities—a satisfactory finding in view of the difficulty of treating cavities in that particular location. The four partial successes were in two patients with fairly extensive and recent exudative disease and two others with cavitation, in one of whom a mid-zone cavity was complicated by a severe tuberculous bronchitis. Fifteen of the seventeen failures presented cavitation. In eleven of these the cavity was of some considerable standing, with surrounding infiltration and fibrosis; and of the remaining four two had tension cavities, a mid-zone cavity discovered after the absorption of an extensive pleural effusion where relatively little elevation of the diaphragm was secured, and an upper zone cavity which should have contracted but did not. Of two other patients to be accounted for, neither had cavitation. The first of these had an extensive and acute tuberculous pneumonia involving an entire lung, while the other had a limited lower zone lesion which should have done well with pneumoperitoneum but for the fact that the diaphragm and upper surface of the liver were found to be densely adherent, and no elevation resulted.

In the second sub-group are those patients in whom pneumoperitoneum was used solely with the aim of preparation for major surgery. In some of these the contralateral lung was the objective, in others the aim was to control a recent bronchogenic spread in the homolateral lung or to reduce the size of

a giant cavity and thus render it more amenable to thoracoplasty. As expected, the limited objective was reflected in the higher rate of successful results recorded. Thus, where the homolateral side was involved, sixteen cases out of nineteen were successful, and there were only two complete failures. As has already been indicated, a successful result has been claimed whenever such patients were converted by means of pneumoperitoneum from poor or impossible surgical risks into reasonable ones, or when, as happened in one or two instances, the pneumoperitoneum was so unexpectedly successful as to render further intervention unnecessary. Studying the sixteen successes in a little more detail, we find that eight of these patients had upper zone cavitation with recent exudative disease in either the mid or lower zones which contra-indicated early thoracoplasty, four had very large upper zone cavities which were considered too large for immediate operation, two had acute pneumonic lesions involving the upper half of the lung, while the remaining one, in addition to his apical cavity, showed a recent cavity of some size at the hilum. Six of these patients have already had their thoracoplasties, and three others are ready for operation; while in seven the results with pneumoperitoneum were so gratifying that thoracoplasty has faded out of the picture. The partial success and the two failures occurred in two subjects with very old-standing disease and one with a tuberculous empyema.

Out of a total of eight patients in whom pneumoperitoneum was used to control disease in the contralateral lung, five showed a successful result. One of these had a small apical cavity, three had extensive mid and upper zone infiltration, and the fifth had a recent basal spread. Three of the five have undergone successful thoracoplasties. The remaining two are rather remarkable in that, following the contralateral phrenic and the induction of the pneumoperitoneum, the original homolateral cavities (which in both instances had persisted unchanged for months) began to contract and eventually healed completely. One must assume that the minor degree of elevation of the unparalysed diaphragm which followed the introduction of air played some part in this result. One of the two partial successes will probably graduate in the course of this year into the successful section, but the other is unlikely to improve further. The one failure in the group was admitted with an empyema on his homolateral side. His contralateral lung showed some infiltration, but this might have responded had he not developed a bronchopleural fistula, followed by a violent extension of the disease, which wrecked the whole scheme.

The remaining column in the table deals with four far advanced cases. Some of these represent our early efforts with pneumoperitoneum, and in them we hoped for nothing except perhaps some alleviation of symptoms. The therapeutic results were precisely nil.

Complications

It has been claimed that pneumoperitoneum is relatively free from many of the undesirable sequelæ which may mar the course of pneumothorax, and on the whole this is probably a fair statement. In this series peritoneal effusions were detected in four cases. One of these developed into a fulminating tuberculous peritonitis from which the patient died, but the other three gave no cause for anxiety and the effusion appeared to absorb gradually. Except

in the first case the onset of the effusion was not associated with any constitutional disturbance. It will be appreciated, of course, that it is probably impossible to detect small effusions in the peritoneal cavity with any degree of certainty, and while four only are mentioned it is not claimed that these were the only effusions in the series. In another patient refills had to be terminated early on because of signs of cardiac embarrassment. Cessation of refills relieved the situation within a few days. Mild mediastinal emphysema occurred in one subject. In another the bowel was accidentally perforated during a refill, but the only result of the accident was the subsequent passage of a large volume of flatus. Further refills proceeded without incident. There was one example of air embolism. On getting off the operating table the patient suddenly collapsed, and a few moments later developed violent convulsions. These continued for about twenty minutes, then gradually subsided, leaving the victim with a severe headache. Twelve hours later this symptom had disappeared completely. The patient was perhaps a little apprehensive when he paraded for his next refill, but all went well and there were no further incidents. Rilance and Warring (1944) have suggested that acute appendicitis is more common in patients receiving pneumoperitoneum. In this series two such cases required operation.

It is worth mention that in two instances the liver and diaphragm were found to be firmly adherent and no elevation of the diaphragm was secured. In two others a good diaphragmatic rise was obtained, but, as the result of undue prolongation of the refill interval, adhesion formation occurred between the diaphragm and the upper surface of the liver and the subdiaphragmatic air space obliterated. This suggested that the claim by some workers that pneumoperitoneum can be terminated and restarted at will should be accepted with a certain reserve.

It has been said that patients receiving pneumoperitoneum tend to show a steady decline in weight. With one or two exceptions this has not been a feature of these cases.

Apart from the usual initial pain referred to the opposite shoulder, few patients have complained of discomfort. The very few with persistent discomfort were all over forty-five years of age, which suggests that the procedure may not be well tolerated by the higher age group.

Duration of Treatment

How long should a pneumoperitoneum be maintained? The answer depends, of course, on the reasons for its use in the particular case. When used as a sole measure of collapse, then, if successful, it should be regarded in the same light as a pneumothorax and maintained for a similar length of time. Thus one patient in this series who started treatment in July 1944 is still receiving refills at four-weekly intervals. Many others have been on refills for periods up to two years, and are likely to continue them for another year before cessation of treatment is considered. The only real inconvenience attached to a long-term pneumoperitoneum lies in the necessity for recrushing the phrenic nerve as the occasion arises—a procedure which is not always popular with the surgeon. In many in this series, however, the nerve has been recrushed two or three times without difficulty.

The short-term pneumoperitoneum case, that is the case in which the treatment is utilised solely as a preparation for thoracoplasty, may cease refills at a much earlier date. Where the homolateral lung has been treated the average duration in this series has been eight months, refills being terminated a few weeks before the operation. Where the treatment was directed towards the contralateral side the average duration was ten months. So far in the contralateral group we have preferred to terminate refills before operation, but there is no real reason why they should not be carried on until after the operation if necessary.

Discussion

Can one venture to formulate any opinion from one's experience with this series upon the indications for pneumoperitoneum and upon the likelihood of success with the method in any given case? One cannot be dogmatic following experience of seventy-four cases—the number is obviously quite insufficient. The most that one can do is to record certain impressions which have been formed, while reserving the right to modify these impressions in the light of further experience.

In a previous publication (Keers, Rigden and Steen, 1947) it was stated that where pneumoperitoneum was used as a single procedure the most notable success was found when the disease was confined to the lower zone. Subsequent events, however, suggest that this statement should be amended, and it is now considered that lesions in the upper half of the lung field are just as likely to respond satisfactorily as those situated in the lower half. The nature of the lesion appears to be important. One would not expect a thick-walled cavity with much surrounding fibrosis, wherever situated, to yield to what is essentially an example of minor relaxation therapy. This has been borne out in practice. On the other hand, a fibrotic lesion which is still contracting may be materially assisted by an adequate elevation of the diaphragm. A distinction must be drawn between these two types. Purely exudative disease and cavitation of recent origin, wherever situated, have on the whole responded well, and it would appear reasonable to try pneumoperitoneum for such lesions should pneumothorax prove impracticable. It has been found very useful in cases of really acute exudation, where pneumothorax would have been accompanied by all its undesirable sequelæ; also in two patients with tuberculous pneumonia where the consolidation was limited to one lobe. Another case, in which the pneumonic process involved the entire lung, showed no benefit whatsoever. Pneumoperitoneum is also worth a trial in patients with a dorsal lobe cavity. Three such cavities in this series all obliterated satisfactorily, closure being confirmed by tomography.

I hope that I have succeeded in making out a case for pneumoperitoneum and for its retention as a method of treatment in certain selected cases of pulmonary tuberculosis. I believe that the conflicting reports about its efficiency have been due not so much to any inherent defect in the method itself but to an over-optimistic estimate of its potentialities, leading to its indiscriminate application in most unsuitable clinical material. I would emphasise once more that pneumoperitoneum is not to be preferred to a satisfactory and uncomplicated pneumothorax, but that, failing this, it may

PLATE XI

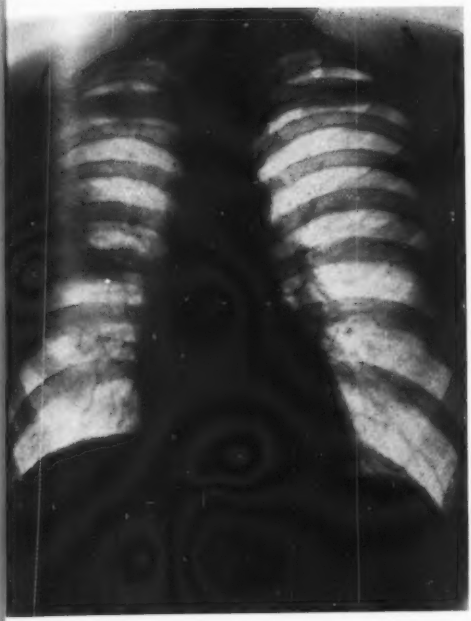

FIG. 1.

FIG. 2.

FIG. 3.

FIG. 4.

To face p. 64

FIG. 5.

FIG. 6.

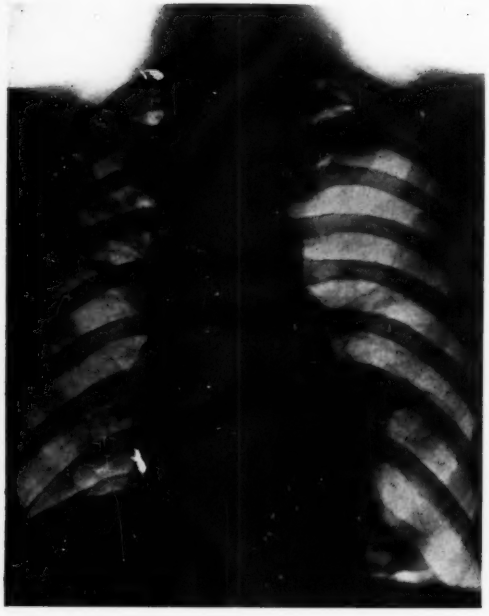

FIG. 7.

FIG. 8.

To face p. 63

prove a reasonable alternative. Its most fruitful results have been obtained when it has been used prior to thoracoplasty, and I am convinced that many such patients in this series would have fared ill without its aid.

Illustrative Cases

Pneumoperitoneum as the sole procedure.

Case 1.—Mr. M. Aged 26. Admitted May 1945. T.B. Positive. B.S.R. 10 mm. X-ray (Fig. 1, Plate XI) infiltration right upper and mid zones. History of previous right pleural effusion. Right phrenic crush and pneumoperitoneum May 1945. Discharged July 1946 (Fig. 2, Plate XI). T.B. Negative previous nine months. February 1948 very well. Full work. Refills every two weeks.

Case 2.—Miss McC. Aged 25. Admitted July 1946. T.B. Positive. B.S.R. 45 mm. X-ray (Fig. 3, Plate XI) slight infiltration in right upper zone and large cavity in left upper zone. Left phrenic crush and pneumoperitoneum August 1946. Cavity shrinkage occurred, but without final closure. "Transient" L.A.P. January 1947 to alter relationship of draining bronchus. Maintained ten days only. Cavity closure followed within a month, confirmed by tomograms. Discharged February 1948 (Fig. 4, Plate XI) very well. T.B. Negative. Refills every two weeks.

Pneumoperitoneum as prelude to major surgery (homolateral lung).

Case 3.—Mr. M. Aged 25. Admitted June 1946. Febrile. T.B. Positive. B.S.R. 54 mm. Laryngeal lesion. X-ray (Fig. 5, Plate XII) infiltration right upper and mid zones, with large cavity in upper zone. Infiltration also left mid and lower zones. Right phrenic crush and pneumoperitoneum July 1946, with view to later thoracoplasty. L.A.P. August 1946. Steady improvement (Fig. 6, Plate XII) October 1946. Pneumoperitoneum terminated July 1947. Subsequent X-ray (Fig. 7, Plate XII) almost complete cavity obliteration. Left upper thoracoplasty without apicolysis September 1947. February 1948 (Fig. 8, Plate XII) ready for discharge. Very well. T.B. Negative. B.S.R. 3 mm. Larynx healed. L.A.P. refills every two weeks.

Case 4.—Mr. D. Aged 22. Admitted October 1945. T.B. Positive. B.S.R. 60 mm. X-ray (Fig. 9, Plate XIII) extensive exudative disease upper half of right lung, with scattered foci in left mid and lower zones. Right phrenic crush and pneumoperitoneum January 1946, with view to later right thoracoplasty. Steady progress thereafter, with clearing of lesion in right lung. Thoracoplasty unnecessary. Discharged December 1946 (Fig. 10, Plate XIII). T.B. Negative. B.S.R. 5 mm. February 1948 very well. Full work. Refills every two weeks.

Pneumoperitoneum as prelude to major surgery (contralateral lung).

Case 5.—Mrs. McK. Aged 30. Admitted October 1944. T.B. Positive. B.S.R. 47 mm. X-ray (Fig. 11, Plate XIII) infiltration right upper and mid zones, with large cavity in upper zone, also recent infiltration left lower zone. Four months' strict bed rest before admission without improvement. Left phrenic crush and pneumoperitoneum October 1944, with view to later right thoracoplasty. Subsequent steady improvement in both lungs, with eventual clearing of left base and closure of right upper zone cavity (Fig. 12, Plate XIII) confirmed by tomograms. Refills terminated November 1945. Discharged December 1945. T.B. Negative. February 1948 very well. Normal life.

REFERENCES

Anderson, N. C., and Winn, W. D. (1945): *Amer. Rev. Tuberc.*, **52**, 380.
Banyai, A. L. (1934): *Amer. Rev. Tuberc.*, **29**, 603.

BANYAI, A. L. (1946): " Pneumoperitoneum Treatment," Kimpton, London.
CLIFFORD-JONES, E., and MACDONALD, N. (1943): *Tubercle*, **24**, 97.
CROW, H. E., and WHELCHEL, F. C. (1945): *Amer. Rev. Tuberc.*, **52**, 367.
DROLET, G. J. (1943): *Amer. Rev. Tuberc.*, **47**, 197.
EDWARDS, P. W., and LOGAN, J. (1945): *Tubercle*, **26**, 11.
FOWLER, W. O. (1941): *Amer. Rev. Tuberc.*, **44**, 474.
GILMORE, D. J. (1947): *Diseases of the Chest*, **13**, 153.
HURST, A., MAIER, H. M., and DWORK, R. (1947): *Diseases of the Chest*, **13**, 345.
KEERS, R. Y., RIGDEN, B. G., and STEEN, P. (1947): *Edinb. Med. J.*, **54**, 30.
MITCHELL, R. S., HIAT, J. S., MCCAIN, P. P., EASOM, H. F., and THOMAS, C. D. (1947): *Amer. Rev. Tuberc.*, **55**, 306.
MURPHY, J. D. (1947): *Diseases of the Chest*, **13**, 631.
PINNER, M. (1945): " Pulmonary Tuberculosis in the Adult," Thomas, Springfield.
RILANCE, A. B., and WARRING, F. C. (1941): *Amer. Rev. Tuberc.*, **44**, 323.
RILANCE, A. B., and WARRING, F. C. (1944): *Amer. Rev. Tuberc.*, **49**, 353.

POLYARTERITIS NODOSA WITH PULMONARY MANIFESTATIONS AND CARDIAC FAILURE

BY M. S. R. HUTT

From an R.A.F. General Hospital

Case Report

AN R.A.F. warrant officer, aged 24, first became ill in May 1946. He had seen service, including full operational duties as an observer, in South and West Africa, Italy, India and Burma. No history of any tropical disease could be obtained; nor was there any past or family history of chest trouble, asthma, skin disease, or other allergic phenomena.

The natural history of his complaint falls roughly into three stages, the first stage being characterised predominantly by pulmonary and gastro-intestinal symptoms. This began insidiously in May 1946 with a coryzal attack, followed by a productive cough. It gradually increased in severity, and was accompanied in July by typical asthmatic attacks. A radiogram of the chest taken on June 26 showed no abnormality, but another on July 24 showed a small opacity in the left infra-clavicular region, suggesting an early tuberculous lesion with softening in the centre (Plate XIV, Fig. 1). During the latter part of July and August he remained in bed at home under medical supervision.

On August 23 he was transferred to an R.A.F. hospital. On arrival, after a long ambulance journey, he was dyspnœic and distressed but able to walk to the ward. Examination revealed signs which were " suggestive of bilateral basal broncho-pneumonia." There is no record of asthmatic symptoms or signs at this time. A course of sulphapyridine was started on arrival, 25 grams being given in all. Radiograms on September 5 and 30 showed some reticular mottling in both lung fields, mainly at the bases, with enlarged hilar shadows, a prominent interlobar septum and a progressive enlargement of the heart. The shadow previously seen in the earlier X-ray had gone (Plate XIV, Fig. 2).

Just prior to admission he developed diarrhœa, which now became worse, the stools containing both blood and mucus. Culture revealed on one occasion an atypical dysentery bacillus, and as this was thought at the time to be the

PLATE XIII.

FIG. 9.

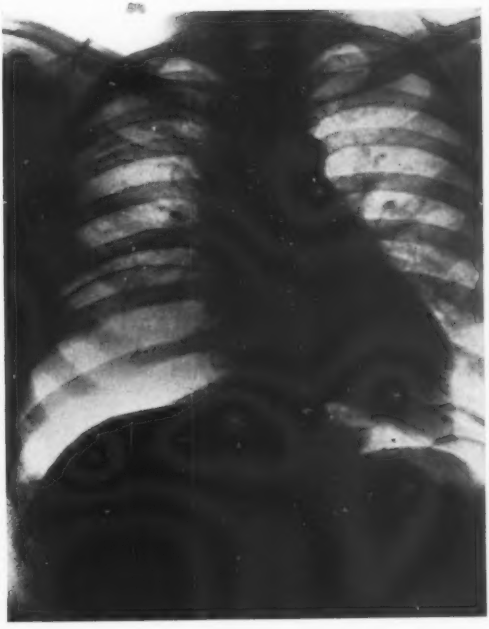

FIG. 10

FIG. 11.

FIG. 12.

To face p. 66

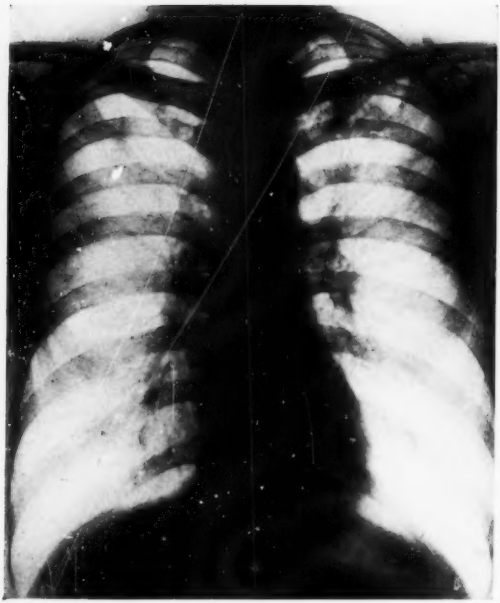

FIG. 1.—POSTERO-ANTERIOR RADIOGRAPH, JULY, 1946, SHOWING AN AREA OF INFILTRATION IN THE LEFT INFRACLAVICULAR REGION.
Normal cardiac outline.

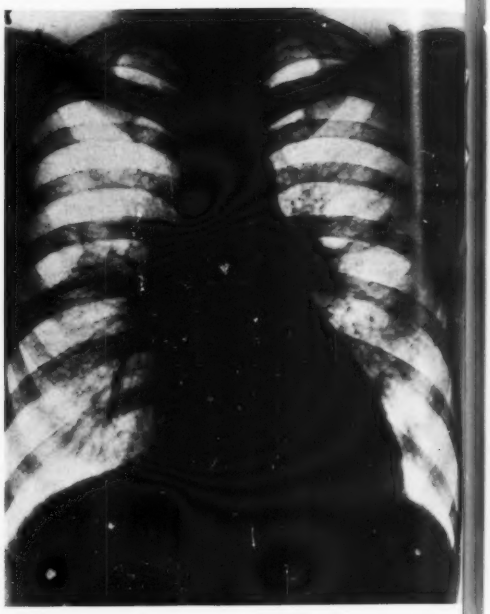

FIG. 2.—POSTERO-ANTERIOR RADIOGRAPH, SEPTEMB 1946, SHOWING ENLARGED HILAR SHADOWS WI INCREASED VASCULAR MARKINGS, A PROMIN INTERLOBAR SEPTUM AND ENLARGED CARDIAC O LINE.

FIG. 3.—POSTERO-ANTERIOR RADIOGRAPH, DECEMBER, 1946, SHOWING GROSS CARDIAC ENLARGEMENT WITH AN OPACITY SUGGESTING LOBULAR COLLAPSE AT THE RIGHT BASE.

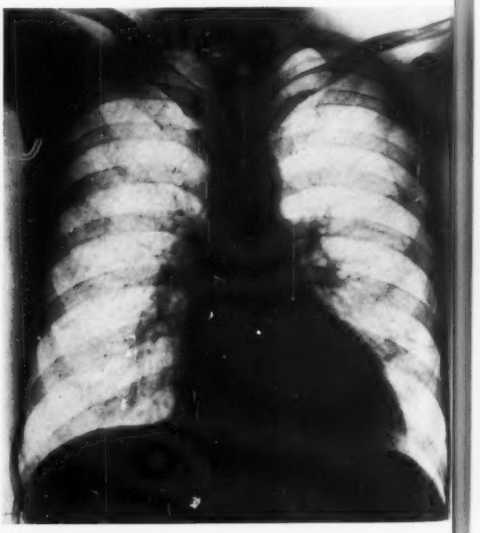

FIG. 4.—POSTERO-ANTERIOR RADIOGRAPH, AUGUS 1947, SHOWING DIMINUTION IN THE SIZE OF CARDI OUTLINE.
The lung fields are clear.

To face p. 67

cause of his intestinal symptoms he was treated by a course of sulphaguanidine, 150 grams, following the sulphapyridine, with slight improvement in his general condition. Other investigations at this time were a B.S.R. of 35 mm. in the first hour, a W.B.C. count of 7,600 cells per c.mm., of which 16 per cent. were eosinophils, and several examinations of sputa, which were all negative for acid-fast bacilli.

On October 14, 1946, he was transferred to another R.A.F. hospital for further investigation. He still complained of cough, with attacks of dyspnœa and of intermittent diarrhœa. He looked ill and had a low-grade pyrexia and a constant tachycardia. Also, by now there was some cardiac enlargement, with gallop rhythm and an apical systolic murmur. Apart from inconstant basal râles, there were no abnormal signs in the respiratory system. His B.S.R. was 33 mm. in an hour, his W.B.C. count showed 56 per cent. of eosinophils, while a mid-stream specimen of urine showed no albumen or cells in the deposit and stool cultures failed to grow any pathogenic organisms. Sigmoidoscopy revealed a normal mucosa as far as the recto-sigmoid junction, with blood coming down from higher up.

The combination of fleeting pulmonary signs with eosinophilia suggested tropical eosinophilia as a cause for these symptoms, but no therapeutic response was obtained to a full course of carbarsone gr. 4 b.d. for ten days, along with intravenous neoarsphenamine 0·3 G. for seven injections. A W.B.C. count on November 28 following this treatment showed 18,000 cells per cmm., with 43 per cent. of eosinophils. At this time the diarrhœa had ceased, but dyspnœa and cough continued.

In December he entered the second stage of his illness, manifested chiefly by cardiac symptoms and signs. Early signs of right-sided cardiac failure became apparent and increased during the month. He had a constant tachycardia, but no irregularities were noted. In spite of digitalis and twice-weekly injections of mersalyl, his condition became worse. On December 23 another radiogram (Plate XIII, Fig. 3) showed gross cardiac enlargement, with basal congestion and a fresh opacity filling in the right cardiophrenic angle with a straight well-defined margin. The previous shadowing was diminished.

On January 9, 1947, he was transferred to another R.A.F. hospital to be near his home. On admission he presented all the signs of right-sided cardiac failure, with a constant regular tachycardia and a normal blood pressure. There was marked cardiac enlargement to the left, a gallop rhythm and an apical systolic murmur. Both lungs had a diminished air entry and many râles at both bases. In view of the radiological findings, percardial effusion was considered, but at no time in his illness did it receive any support from clinical findings. Treatment was continued with digitalis and mersalyl, and with frequent periods of oxygen administration needed to alleviate his dyspnœa. On January 13 a blood count showed Hb. 95 per cent. (Haldane) R.B.C.'s 5,000,000 per c.mm. and W.B.C.'s 6,500 per c.mm., with no increase of eosinophils.

During the next four weeks there was little change in his general condition. In February pulse irregularities were noticed for the first time, and an E.C.G. on March 6 showed auricular fibrillation with the ventricular rate controlled by digitalis.

On March 9 he began to have frequent attacks of cerebral anoxæmia; these were associated with sudden doubling or halving of the apex rate as if from flutter with changing block, although unfortunately no electro-cardiograph was obtained to confirm this. At the beginning of April he improved slightly, becoming apyrexial and free from pulse abnormalities except for some increase in rate. On April 13 vitamin B_1 100 mgm. daily was given as a therapeutic test; this was continued for two weeks, and then reduced to 10 mgm. daily. Improvement continued becoming more definite, dyspnœa and œdema were lessening and during the ensuing weeks gradually faded. By May 23, although the cardiac enlargement was scarcely altered radiologically, the gallop rhythm had gone and his signs of right-sided cardiac failure also, though the liver was still just palpable but not tender.

In June the third stage of the illness began with a return of the original symptoms. It began with a recurrence of asthmatic attacks, increasing in severity and needing frequent injections of adrenaline and intravenous aminophylin. Typical expiratory rhonchi tended to persist between attacks. A W.B.C. count on June 11 showed 14,000 cells per c.mm., with 9 per cent. of eosinophils. No relief was obtained by treatment with benadryl 50 mgm. t.d.s. for fourteen days.

On June 21 there was a recurrence of diarrhœa, a symptom which had not been present for six months. The stools again contained blood, but were sterile on culture. The attack was soon controlled by symptomatic treatment and did not recur. Intermittent attacks of asthma continued throughout July and August, but were controlled by ephedrine and adrenaline. They were associated with great anxiety, and there is little doubt that at this time psychological factors played a large part in their production.

There was, however, no repetition of the cardiac failure, and by August 14 there was obvious diminution in the size of the cardiac shadow and the lung fields were clear (Plate XIII, Fig. 4). He was now allowed up slowly.

At the end of September he again had attacks of asthma associated with a low-grade pyrexia and bronchitic signs. He was given a full course of sulphamezathine, and soon improved. In October another radiogram showed the cardiac shadow to be approaching normal limits. During this and the following month he gradually increased his physical activities with no ill-effects. There were no recurrences of asthma, and in a further two months' time he was almost fully ambulant, though still unable to undertake strenuous exertion.

Discussion

The interpretation of the original pulmonary changes in this patient is difficult because details are lacking. It seems probable, however, that they can be ascribed to a single pathological process.

The rapid resolution of the infraclavicular shadow and the clinical course of the disease exclude a tuberculous lesion. Bronchopneumonia seems unlikely in view of the absence of leucocytosis, the presence of eosinophilia and the subsequent progress of the case. Tropical eosinophilia was considered, but no therapeutic response was obtained from carbarsone and intravenous N.A.B.

The combination of asthma with transient pulmonary infiltrations and eosinophilias uggested an allergic reaction to some unknown antigen. Sulphon-

amides cannot be incriminated, as there is no record of their administration before the radiographic changes occurred. Harkavy (1941) reported transitory pulmonary infiltrations, similar to those found in Löffler's syndrome, in a series of asthmatic patients. One of these cases eventually developed the typical lesions of polyarteritis nodosa. He considered that the pathological process is due to vascular damage of an allergic nature which may, as in the case he described, extend to produce the pathological picture of polyarteritis nodosa. Elkeles and Glynn (1944) surveyed the literature of pulmonary involvement in polyarteritis nodosa. They discussed serial röntgenograms of the chest in an example. The main radiological features are increased vascular markings, particularly involving the hilar regions and the bases, and transitory infiltrations, usually affecting the lower zones but sparing the periphery. They compared the pathological findings to those produced in Rich's (1943) experimental animals by the induction of hypersensitivity to foreign serum, several of these animals showing typical pulmonary vascular lesions.

The second aspect of this case to be considered is the cause of his gastro-intestinal symptoms. It would seem justifiable to discount the single finding of an atypical dysentery bacillus in view of the clinical history. Ulcerative colitis was believed to be the cause of these symptoms during his original attack; sigmoidoscopy, however, failed to reveal any changes characteristic of this disease. It is reasonable to suppose, therefore, that these symptoms were caused by a similar pathological process to that occurring in the lungs, *i.e.*, that there was vascular damage due to an allergic process causing hæmorrhage into the bowel. " Bloody diarrhœa " due to this type of reaction has been reviewed by Daley and Miller (1946) in cases of polyarteritis nodosa.

Finally the cause of the cardiac manifestations has to be considered and co-related with the other clinical findings. Cor pulmonale can reasonably be excluded, as the pulmonary signs were regressing before the onset of cardiac failure. Although there had been some improvement prior to administration of vitamin B_1 (100 mgm. daily), there appeared to be a definite response to this treatment. Although a deficiency conditioned by the chronic diarrhœa may have been responsible in part for the cardiac condition, no other signs of vitamin B deficiency were found at any time during his illness. A complicating pericardial effusion was also considered, but was discarded on clinical grounds at numerous examinations.

It was felt, in view of these considerations, that the heart failure was mainly due to myocardial damage secondary to allergic angeitis involving the coronary arterioles. Recently Daley and Miller (1946) have reviewed cases of cardiac involvement in polyarteritis nodosa. They described the pathological findings in a patient who died from cardiac failure; typical lesions were found in the myocardial arterioles. It is possible to correlate the varying findings in the patient reported here on this basis, for they fit better with an allergic reaction of the type found in polyarteritis nodosa than with anything else. It now seems certain that this disease is a specific tissue reaction of a hyper-sensitive nature caused by various antigens, either bacterial or chemical. The disease process may involve all organs of the body or affect only one structure, a point which accounts for the negative result of a muscle biopsy in this patient, and also for the absence of hypertension or other evidence of renal involvement.

This patient illustrates also some of the variable manifestations that may be found in polyarteritis nodosa and emphasises that recovery may occur even when the disease is severe.

Summary

A patient is described whose illness had, as its salient features, transient pulmonary opacities, eosinophilia and hæmorrhagic diarrhœa followed by heart failure with recovery. Reasons are given for considering an allergic angeitis, comparable to polyarteritis nodosa, as the cause.

My thanks are due to the D.G.M.S., R.A.F., for permission to publish this article and to Wing-Cmdr. J. E. G. Pearson for his help and encouragement.

REFERENCES

ELKELES, A., and GLYNN, L. E. (1944): *Brit. J. Radiol.*, **17**, 368.
HARKAVY, J. (1941): *Arch. intern. Med.*, **67**, 709.
LÖFFLER, W. (1936): *Schweiz. med. Wschr.*, **66**, 1069.
MILLER, H. G., and DALEY, R. (1946): *Quart. J. Med.*, **15**, 255.
RICH, A. R. (1942): *Bull. Johns Hopkins Hosp.*, **71**, 123 and 375; (1945) *ibid.*, **77**, 43.
RICH, A. R., and GREGORY, J. E. (1943): *Ibid.*, **72**, 65.

SCROTAL PNEUMOCELE COMPLICATING ARTIFICIAL PNEUMOPERITONEUM

BY H. MELTZER

From the Charles Camsell Indian Hospital, Edmonton, Alberta, Canada

INDUCED pneumoperitoneum to increase intra-abdominal pressure, raise the diaphragm and cause partial lung collapse is an extremely useful adjunct in the treatment of tuberculosis. This collapse can be made predominantly unilateral by interrupting the phrenic nerve on one side. The use of this means of treatment in selected cases and in conjunction with other forms of collapse therapy is becoming more widespread and appreciated.

Complications are relatively rare. Aronovitch, Caswell and Zadé report that in over 1,200 refills they have had no major complications. They had one major complication on induction—a transient hemiplegia with subsequent recovery. Mediastinal emphysema may possibly occur. Subcutaneous emphysema does occur in some cases, due to faulty position of the filling needle. Minor peritoneal effusions occasionally develop but offer no bar to continuing treatment. Many patients have pain in the region of the shoulder for the first few refills. It is possible that some cases may develop peritoneal adhesions. The fear of puncturing the bowel seems remote if care is practised during induction and subsequent refills.

This report presents a very rare complication in a case under our observation and tends to substantiate the conclusion of others that a scrotal pneumocele does not necessitate cessation of therapy. The case also illustrates the use of induced pneumoperitoneum in conjunction with other means of collapse therapy, namely phrenic nerve crush and pneumothorax.

Case Record

A.H., age 14 years, was admitted to the Charles Camsell Indian Hospital on December 10, 1946, complaining only of cough of several months' duration. He looked ill and was underweight. His past history was essentially negative, with no definitely known tuberculosis contact. On examination there were râles in the upper half of the left lung with signs of cavitation. X-ray films showed gross infiltration in the left lung from the apex to the fourth rib, with a 4-cm. cavity present; in the right lung there was infiltration from the apex to the second rib. A diagnosis was made of active far advanced bilateral pulmonary tuberculosis. His pulse range was 65-100, temperature 97-100°F., respirations 15-25, sedimentation rate 79 mm. (Westergren), hæmoglobin 75 per cent., sputum Gaffky VII, urine negative, and weight 78 pounds.

On six weeks' absolute bed-rest he gained 9 pounds in weight, his sedimentation rate dropped to 22 mm., and his hæmoglobin rose to 97 per cent. Other findings remained unchanged. On February 8, 1947, a left artificial pneumothorax was started, but as widespread adhesions over the upper lobe prevented cavity closure the pneumothorax was discontinued after four refills. In March an artificial pneumothorax was started on the right side. Radiograms then showed a left pleural effusion residual to the pneumothorax on that side. The right lung showed a selective collapse—40 per cent. apical and hilar, 25 per cent. basal.

The patient was very active and difficult to retain on strict bed rest. In July his case was reviewed, and it was felt that his main disease in the left lung was progressive. The effusion seen in March was clearing. There was also a distinct irregular cavity seen in the partially collapsed upper right lobe. It was decided that a pneumoperitoneum should be tried, that a left phrenic crush might follow, and that the right pneumothorax should be continued.

On August 2, under local anæsthetic, 450 c.c. of air were introduced intraperitoneally at the lateral border of the left rectus muscle just above the transumbilical line. Refills of 500 to 600 c.c. were continued twice a week, with right pneumothorax refills of 250 c.c. weekly. On August 26 a left phrenic nerve crush was done. X-ray on September 13 showed a good elevation of the left diaphragm, with a moderate amount of air under both diaphragms. The left basal effusion had completely disappeared. While there was still gross disease in the left upper lung field, the cavity formerly seen was definitely less distinct and smaller. On the right side the pneumothorax was going well. The disease in the right upper lobe was definitely more fibrous in appearance, but slight honeycombing was still apparent. At this time the boy's sedimentation rate was 19 mm., his blood picture essentially unchanged, sputum lessened in amount and on direct smear was Gaffky I; his pyrexia, too, showed a distinct tendency to diminish, and the overall clinical picture was greatly improved. In October and November sputum was negative for tubercle bacilli.

On November 10, during the course of a typical pneumoperitoneum refill, the patient complained of mild indefinite pain in the lower abdomen. Within an hour he had pain in the left groin spreading into the scrotum. The scrotum gradually became swollen to the size of a goose egg within three hours. On examination the air was found to be in the left scrotal sac. The skin was tense, raphe displaced to the right and rugæ obliterated. The testicle was lying at the bottom of the sac. The scrotum and inguinal region were tender, with the latter somewhat swollen. There was no trace of surgical emphysema. Other than pain there was no constitutional disturbance. The pain decreased rapidly in the ensuing twenty-four hours, the swelling gradually subsided and

had completely disappeared at the end of six days. Examination at this time revealed no abnormalities of scrotum or inguinal canal.

On November 13 he received the usual pneumoperitoneal refill without any evidence of air leakage into the scrotum, and since then has been taking air with no difficulty or recurrence of the scrotal pneumocele.

A radiogram on December 8, 1947, showed the disease much improved in the left lung, with no definite signs of cavitation. The disease in the partially collapsed right lung was improved and honeycombing less distinct.

Discussion

Scrotal pneumocele as a complication of artificial pneumoperitoneum is rarely mentioned in the literature. Rogers and Garnett (1947) report a case developing on induction which subsided in nine days. They then continued treatment without any recurrence of the complication. They also quote Basta (1934), Banyai (1946), and Monto and Bradford (1943). Banyai's case had been receiving refills for seven months when the complication suddenly developed, but disappeared in four days. Monto and Bradford used a pressure pad on the inguinal ring to help prevent recurrence, but found it unnecessary.

Rogers and Garnett maintain that the explanation of the mechanism by which a scrotal pneumocele develops is to be found in the embryological development of the area. " In late fœtal life a diverticulum of peritoneum—the processus vaginalis—projects from the abdominal wall into the scrotum, forming the inguinal canal as it does so. Later the testes migrate from the abdomen into the scrotum, passing along the posterior wall of the processus vaginalis and invaginating its lower part. In early infancy the connection between the peritoneal and scrotal sacs normally becomes obliterated and the scrotal portion forms the tunica vaginalis. Various abnormalities occur. The processus vaginalis may remain patent or there may be only a thin membrane separating the two cavities."

In all cases quoted the complication rapidly disappeared after a few days spontaneously. In Monto and Bradford's case closure may have been assisted by a pad. It would seem, therefore, that in none of these cases was there a patent processus vaginalis. It is more likely that air pressure forced apart weakly adherent walls of the processus vaginalis, following which there was healing of the traumatised tissues. The absence of recurrence suggests that the process of healing strengthened the congenital weakness previously present.

From the literature to date and from our own experience with the case reported it does not appear that the development of a scrotal pneumocele is in any way a contraindication to continuance of pneumoperitoneum.

Summary

A case of scrotal pneumocele developing three months after induction of pneumoperitoneum is reported. Treatment was continued without any evidence of recurrence. It is suggested that this rare complication is not a contraindication to continuance of pneumoperitoneum.

BIBLIOGRAPHY

ROGERS, W. N., and GARNETT, J. V. (1947): *Brit. J. Tuberc.*, **12.**
ARONOVITCH, M., CASWELL, L. A., and ZADE, J. A. (1947): *Canad. Med. Ass. J.*, **57.**

NOTICE

TUBERCULOSIS ASSOCIATION

RESEARCH COMMITTEE

In 1947 the Tuberculosis Association decided to set up a Committee which would play a part in the co-ordination of research into problems connected with tuberculosis in England, Wales and Northern Ireland. The body now in being consists of members who are authorities in the special field and it is under the Chairmanship of Dr. F. R. G. Heaf, President of the Association. It includes an observer from the Ministry of Health and representatives of the Joint Tuberculosis Council and the Tuberculosis Society of Scotland. (There will be close liaison with a special Sub-Committee of the latter.)

The Committee is, of course, representative of the great fund of clinical and experimental experience comprised in the membership of the Tuberculosis Association and through the connection mentioned above of similar experience in the Scottish Society. Both bodies include those numerous individuals on whom falls the burden of solving tuberculosis problems, and it is hoped that for these the Committee will represent a source of help and encouragement. In giving assistance to workers when asked, there will be no question of interference or direction. It is hoped that investigators will keep the Committee informed as to the nature of work in progress or envisaged and may be assured that all information will be regarded as confidential.

Other functions of the Committee will be to supply, when required, advice on the conduct of larger investigations contemplated by official bodies and manufacturing industries, to draw up schemes for adequate trials of newer methods of treatment, and to suggest to individuals and groups of individuals outstanding problems which they might usefully explore.

The full Committee will meet several times a year and there is a standing Working Sub-Committee to consider problems as they arise.

Communications should be sent to Tuberculosis Association Research Committee, Manson House, 26, Portland Place, London, W.1.

REVIEWS OF BOOKS

Tuberculosis in Young Adults. Report on the Prophit Tuberculosis Survey, 1935-1944. By Marc Daniels, M.D., D.P.H., Frank Ridehalgh, M.A., M.B., B.Ch., M.R.C.P., and V. H. Springett, M.B., B.S. Lewis, London. Pp. xvi+228. 30s.

The Prophit Survey was originally intended to comprise a study of 5,000 persons in each of five groups. These groups were: (1) contacts attending tuberculosis dispensaries who were living in a family with a case of pulmonary tuberculosis and who were known to be exposed to a relatively high degree of infection; (2) controls, who were mainly office workers, regarded as representing the average urban citizen; (3) nurses employed in large general hospitals, which were classified in two groups—namely, A, hospitals admitting all types of cases including those with advanced tuberculosis, and B, hospitals admitting patients who were more carefully selected; (4) medical students, both in their pre-clinical and clinical years; (5) naval training establishment entrants.

Owing to the outbreak of war, the numbers involved in the Survey had to

be drastically reduced; the group of naval entrants had to be given up; and the difficulties encountered in the Survey were greatly increased. In all, rather more than 10,000 young people were observed over the period of ten years; and the results of this painstaking and thorough observation make fascinating reading.

The tuberculin tests on entry to the Survey showed that the incidence of tuberculin sensitisation in young adults is about 85 per cent. for males and 82 per cent. for females. The incidence increases with age, and is 7 to 10 per cent. higher at 23 than at 18 years of age. Groups from urban districts in England, Wales, and Ireland gave approximately the same rate, but groups from rural areas in Ireland and Wales had a definitely lower rate. This represents a considerably higher incidence of tuberculous infection than has recently been reported from Scandinavia.

Repeated tuberculin testing showed that a certain proportion of persons who were tuberculin positive on entry became more strongly positive later. This increase of sensitivity was greatest in the groups which also had the highest rate of Mantoux conversion—that is, the most exposed groups; a fact which suggests that the rise in sensitivity is due to repeated re-infection.

Further, comparison of the total morbidity rates from tuberculosis in the various groups showed that morbidity was higher in each of the Group A hospitals than in any single Group B hospital. This difference applied after exclusion of the Irish and Welsh and, in conjunction with the evidence in relation to change in tuberculin sensitivity, suggests that exposure is an important factor in the development of tuberculosis in young adults, in tuberculin positive as well as in tuberculin negative individuals.

The Mantoux conversion rate for Group B hospital nurses in the first year was 54 per cent.; for Group A hospital nurses it was 80 per cent. The morbidity rate considered in relation to the result of the tuberculin test on entry agreed with the findings of numerous other surveys: for persons tuberculin positive on entry it was 7·3 (expressed as an annual rate per 1,000); in those tuberculin negative it was 23·1. An interesting observation was that after primary infection 45 individuals had radiologically visible primary lesions; of these, 20 developed progressive tuberculosis; of 545 individuals in whom no such lesion was visible, 5·1 per cent. developed tuberculosis.

A vast amount of material is presented in this report which concerns itself with many features of tuberculosis in the young adult including aspects and prognosis of the minimal lesion, and a discussion of pathogenesis and epidemiology. There is also a section setting forth practicable measures for the control of the disease in the community. The presentation of the data is clear and their discussion illuminating. This is a most satisfactory piece of work on which the Prophit scholars are to be congratulated.

H. N.